Exhibit K

Manual versus powered toothbrushing for oral health

Heanue M, Deacon SA, Deery C, Robinson PG, Walmsley AD, Worthington HV, Shaw WC

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Prepared and produced by:

Update Software Ltd, Summertown Pavilion, Middle Way, Oxford OX2 7LG, UK

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ABSTRACT

Background
Specific oral bacteria, generically known as 'dental plaque' are the primary cause of gingivitis (gum disease) and caries. The removal of dental plaque is thought to play a key role in the maintenance of oral health. There is conflicting evidence for the relative merits of manual and powered toothbrushing in achieving this.

Objectives
To compare manual and powered toothbrushes in relation to the removal of plaque, the health of the gingivae, staining and calculus, dependability, adverse effects and cost.

Search strategy
We searched the Cochrane Oral Health Group's Trials Register (to 22/8/02); the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library Issue 3, 2002); MEDLINE (January 1966 to week 5 2002); EMBASE (January 1980 to week 3 July 2002) and CINAHL (January 1982 to June 2002). Manufacturers of powered toothbrushes were contacted for additional published and unpublished trials.

Selection criteria
Trials were selected if they met the following criteria: design-random allocation of participants; participants-general public with uncompromised manual dexterity; intervention- unsupervised manual and powered toothbrushing for at least 4 weeks; primary outcomes-the change in plaque and gingivitis over that period.

Data collection and analysis
Six reviewers independently extracted information in duplicate. Indices for plaque and gingivitis were expressed as standardised values for each study. The effect measure for each meta-analysis was the standardised mean difference (SMD) with the appropriate 95% confidence intervals (CI) using random effects models. Potential sources of heterogeneity were examined, along with sensitivity analyses for the items assessed for quality and publication bias.

Main results
Twenty-nine trials, involving 2547 participants, provided data for the meta-analysis.

Brushes that worked with a rotation oscillation action removed more plaque and reduced gingivitis more effectively than manual brushes in the short and long term. For plaque at 1 to 3 months the SMD was -0.44 (95% CI: -0.66 to -0.21), for gingivitis SMD -0.45 (95% CI: -0.76, -0.15). These represented an 11% reduction on the Quigley Hein plaque index and a 6% reduction on the Löe and Silness gingival index. At over 3 months the effects were SMD for plaque -1.15 (95% CI: -2.02,-0.29) and SMD for gingivitis -0.51 (95% CI: -0.76, -0.25). These represented a 7% reduction on the Quigley Hein Plaque Index and a 17% reduction on the Ainamo Bay Bleeding on Probing Gingival Index. The heterogeneity found in these meta-analyses for short term trials was caused by one trial that had exceptionally low standard deviations. Sensitivity analyses revealed the results to be robust when selecting trials of high quality. There was no evidence of any publication bias.

No other powered brush designs were consistently superior to manual toothbrushes.

In these trials, data on cost, reliability and side effects were inconsistently reported. Those side effects that were reported on in the trials were localised and temporary.

Reviewers' conclusions

Powered toothbrushes with a rotation oscillation action achieve a modest reduction in plaque and gingivitis compared to manual toothbrushing.

Observation of methodological guidelines and greater standardisation of design would benefit both future trials and meta-analyses.

BACKGROUND

Pathogenic bacteria are the primary cause of gingivitis (gum inflammation) and are implicated in the progression to periodontitis (loss of bone around the teeth) although the link between the two is complex and not well understood (Löe 1965).

Plaque is also one of the main causal factors in dental caries, although the evidence of a relationship between oral cleanliness and caries is not clear-cut (Richardson 1977; Addy 1986). When teeth are brushed with a fluoride toothpaste ample evidence of a caries preventative effect is available, but this is due more to the effect of fluoride than brushing per se (Chesters 1992).

Good oral hygiene (the removal of plaque) by effective toothbrushing has a key role in oral health. Effective toothbrushing depends on a number of factors including motivation, knowledge and manual dexterity.

Powered brushes simulate the manual motion of toothbrushes with lateral and rotary movements of the brush head. More recently, there has been a progression towards rotary action brushes (van der Weij 1993a). Brushes which operate at a higher frequency of vibration have also been introduced (Johnson 1994;Terezhalmy 1995b).

Powered toothbrushes were first introduced commercially in the early 1960s (Chilton 1962a; Cross 1962; Hoover 1962; Elliot 1963) and have become established as an alternative to manual methods of toothbrushing. In the UK the volume of sales of powered toothbrushes has nearly doubled each year between 1999 and 2001, increasing from 2% of total sales of all toothbrushes in 1999 to 7% in 2001 (Personal communication, R Davies 2002).

One study has shown that 36 months after purchase, 62% of people were using their electric toothbrushes on a daily basis (Stålneke 1995). The compliance level was high and was unrelated to any social factors of the population studied.

As the powered toothbrush is so popular the common question raised is which is better, the powered or manual?

OBJECTIVES

To compare manual and powered toothbrushes in everyday use, by people of any age, in relation to:
(1) removal of plaque;
(2) inflammation of the gingivae;
(3) removal of staining and calculus;
(4) dependability and cost;
(5) adverse effects.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

The review is confined to randomised controlled trials comparing manual and powered toothbrushes. It excludes trials confined to comparisons between different kinds of powered brushes or those comparing different kinds of manual brushes.

Cross-over trials were eligible. Split mouth trials were excluded, as these were not considered representative of 'everyday use'.

Types of participants

Individuals of any age with no reported disability that might affect toothbrushing were included. Individuals wearing orthodontic appliances were also included.

Types of intervention

The toothbrushes included in the review were all forms of manual brushes and all forms of powered brushes with a mechanical movement of the brush head.

Trials instituting combined interventions, e.g. brushing combined with the use of mouthrinses or irrigation, were excluded. However, trials where participants were permitted to continue with their usual adjuncts to oral hygiene, such as flossing, were included.

Trials were excluded, where the brushing intervention was carried out or was supervised by a professional within 28 days prior to a follow-up assessment.

Trials of 28 days and over were eligible, and a subgroup analysis was carried out on the duration of trials for the different outcome measurements.

Powered toothbrushes were divided into six groups according to their mode of action.

Side to side action, indicates a brush head action that moves laterally side to side.

Counter oscillation, indicates a brush action in which adjacent tufts of bristles (usually 6 to 10 in number) rotate in one direction and then the other, independently. Each tuft rotating in the opposite direction to that adjacent to it.

Rotation oscillation, indicates a brush action in which the brush head rotates in one direction and then the other.

Circular, indicates a brush action in which the brush head rotates in one direction.

Ultrasonic, indicates a brush action where the bristles vibrate at ultrasonic frequencies (> 20 kHz).

Unknown, indicates a brush action that the reviewers have been unable to establish based on the trial report or confirm with the manufacturers.

It was agreed that, analysis of filament arrangement, orientation, size, shape and flexibility, brush head size and shape along with

presence or absence and characteristics of a timer would prove difficult to define across time and brush types.

Types of outcome measures

The primary outcome measures employed were quantified levels of plaque and/or gingivitis. Values recorded on arrival at the assessment were used. Measures taken after participants had been instructed to brush their teeth at the assessment visit were not used.

Secondary outcome measures sought were levels of calculus and staining; dependability and cost of the brush used, including mechanical deterioration; and adverse effects such as hard or soft tissue injury and damage to orthodontic appliances and prostheses.

SEARCH STRATEGY FOR IDENTIFICATION OF STUDIES

The search followed the Cochrane Oral Health Group search strategy (http://www.update-software.com/cochrane/).
The search attempted to identify all relevant randomised controlled trials (RCTs) irrespective of language.

We searched the following databases:
The Cochrane Oral Health Group's Trials Register (to 22/8/02)
The Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library Issue 3, 2002)
MEDLINE (1966 to week 5 2002)
EMBASE (1980 to week 3 July 2002)
CINAHL (1982 to June 2002).

For the identification of trials included in, or considered for this review, detailed search strategies were developed for each database. These were based on the search strategy developed for MEDLINE but revised appropriately for each database to take account of differences in controlled vocabulary and syntax rules.

The MEDLINE search strategy combined the subject search with phases one and two of the Cochrane Sensitive Search Strategy for RCTs (as published in Appendix 5c in the Cochrane Reviewers' Handbook). The subject search used a combination of controlled vocabulary and free text terms and is published in full below. Details of search strategies applied to other databases are available from the contact reviewer.

The search strategy for MEDLINE via OVID:
1.exp Toothbrushing/
2.toothbrush$.mp. [mp=title, abstract, registry number word, mesh subject heading]
3.((tooth or teeth) adj3 clean$).mp. [mp=title, abstract, registry number word, mesh subject heading]
4.1 or 2 or 3
5.manual$.mp. [mp=title, abstract, registry number word, mesh subject heading]
6.conventional$.mp. [mp=title, abstract, registry number word, mesh subject heading]
7.handbrush$.mp. [mp=title, abstract, registry number word, mesh subject heading]
8.5 or 6 or 7
9.power$.mp. [mp=title, abstract, registry number word, mesh subject heading]
10.mechanical$.mp. [mp=title, abstract, registry number word, mesh subject heading]
11.electric$.mp. [mp=title, abstract, registry number word, mesh subject heading]
12.electronic$.mp. [mp=title, abstract, registry number word, mesh subject heading]
13.ultrasonic$.mp. [mp=title, abstract, registry number word, mesh subject heading]
14.sonic$.mp. [mp=title, abstract, registry number word, mesh subject heading]
15."motor driven".mp. [mp=title, abstract, registry number word, mesh subject heading]
16."battery operated".mp. [mp=title, abstract, registry number word, mesh subject heading]
17.automatic$.mp. [mp=title, abstract, registry number word, mesh subject heading]
18.9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
19.4 and 8 and 18

The following journals were identified as sources of frequently cited articles in the electronic search:
Journal of Clinical Dentistry (9 citations); American Journal of Orthodontics and Dentofacial Orthopedics (8 citations); American Journal of Dentistry (8 citations); Journal of Clinical Periodontology (20 citations); Journal of Periodontology (17 citations); Journal of Dental Research (42 citations). As these journals are included in the Oral Health Group's ongoing handsearching programme (http://www.cochrane-oral.man.ac.uk/), no further handsearching was undertaken.

All references cited in the included trials were checked. Identified manufacturers were contacted and additional published or unpublished trial reports requested.

The review is to be updated every 2 years using CENTRAL, the Cochrane Oral Health Group's Trials Register, MEDLINE and EMBASE.

Date of the most recent search was August 2002 (CENTRAL) (The Cochrane Library Issue 3, 2002).

METHODS OF THE REVIEW

Two reviewers independendently reviewed the titles and abstracts identified in the search. If in the opinion of both reviewers an article clearly did not fulfil the defined exclusion criteria it was considered ineligible. Full reports of all trials of possible relevance were obtained for assessment. On receipt of the full article, two reviewers assessed each study independently using specifically designed data extraction forms.

DATA EXTRACTION

Data extraction was performed independently by all reviewers on 10 pilot articles. The reviewers reported back on the design of the data extraction forms and their interpretation of the inclusion and exclusion criteria along with their understanding of the outcome measures. On the basis of this feedback the data extraction forms were altered and the inclusion, exclusion and outcome measures redefined to avoid misinterpretation.

The final data extraction protocol extracted the following information:
(1) Bibliographic details of the study.
(2) Funding source for the trial.
(3) Inclusion eligibility.
(4) Baseline characteristics of the participants in the study, including age, number of participants in the study and gender. Also, specific groups, such as dental students or orthodontic patients were noted, where mentioned.
(5) Intervention characteristics including type of brush and its mode of action, duration of use and delivery of instructions.
(6) Outcomes including plaque and gingivitis indices.

A trial was considered to have adequately generated a random sequence of allocation, if it fully reported the type of allocation generation and it satisfied the CONSORT guidelines as true randomisation (http://www.consort-statement.org/).

A trial was considered to have adequate blinding, if it stated that the method of outcome assessment did not allow the recording clinician to know to which group the participants had been allocated, with no other contradicting statement.

Attrition was considered to have been adequately reported if there was a clear indication of how many withdrawals occurred in each group during the trial and an attempt made to give reasons why the withdrawals occurred.

A trial was considered to have been funded by a brush manufacturer if it was reported that any material sponsorship from the manufacturer occurred, including the donation of brushes. It was considered unclear, if there was no statement on funding. A trial was only considered to be unsponsored by a manufacturer if it clearly stated so.

Trials were considered as 'short term' or 'long term'. 'Short term' data includes follow up between 28 days and 3 months. 'Long term' data includes follow up beyond 3 months. Within each category of long term and short term, where a trial reported multiple end points, only the latest data were extracted.

Data from trials that reported follow up before, and after 3 months were included in the pre- and post-3 month meta-analysis. This was the only circumstance when data from the same trial were considered twice.

Many different indices of plaque and gingivitis were used across trials and some trials reported multiple indices. A frequencies table was prepared of the indices used and they were ranked based on common usage and simplicity. For plaque we extracted, where possible, data reported as the Turesky et al modification of the Quigley-Hein plaque index of 1962 (Quigley 1962;Turesky 1970). For gingival inflammation we extracted where possible data reported as the gingival index of Löe and Silness (Löe 1963) or, if unavailable, bleeding on probing (Ainamo 1975). Data for 'Russell's periodontal index' were excluded because this index fails to distinguish between gingivitis and periodontitis (Russell 1967).

Where available, data were extracted for whole mouth scores as opposed to part mouth scores. Where only part mouth scores were reported in a study, they were extracted and a sensitivity analysis carried out to consider their impact on the results of the review. Part mouth scoring was said to have occurred if plaque and or gingivitis were not recorded around all erupted teeth, except third molars.

Completed data extraction forms were compared. Where there was disagreement between reviewers with regard to any part of the extraction details it was resolved by discussion between the reviewers and a note made on the data collection forms. Any disagreement, unresolved between the two reviewers, was settled by majority vote of the entire panel of six reviewers. Authors were contacted for clarification where necessary.

METHODOLOGICAL QUALITY

Quality assessment was carried out independently in duplicate at the same time as data was extracted. Particular emphasis was placed on allocation concealment ranked using the Cochrane criteria: Grade A: Adequate, B: Unclear, C:Inadequate, and D: Not used.

Consideration was also given to:
(1) Generation of randomisation sequence
(2) A priori calculation of sample size
(3) Blind outcome assessment
(4) Comparability of groups at baseline
(5) Duration of study
(6) Attrition bias
(7) Reliability tests for outcome measures.

Agreement between reviewers, concerning methodological quality, was assessed by calculating kappa values for full mouth recording; adequate allocation concealment; adequate random number generation; adequate blinding of outcome assessor and adequate reporting of attrition.

Numerical data extracted from the included trials was checked by a third reviewer for accuracy and entered into RevMan (version 4.1).

DATA SYNTHESIS

Choice of summary statistic and estimate of overall effect.
Different indices for plaque measure the same concept on different scales, with high correlation between the different indices. The same is true for gingivitis. As it is not possible to combine the results from different indices, the effects were expressed as standardised values, which have no units, before combining. The standardised mean difference (SMD) was

therefore calculated along with the appropriate 95% confidence intervals (CI) and was used as the effect measure for each meta-analysis. As these mean differences for the groups have no inherent clinical value, to express an estimate of the degree of clinical effect they represent, it is necessary to apply them using any one study as an example. Such examples are given later in the discussion. Random effects models were performed throughout.

Assessment of heterogeneity and investigation of reasons for heterogeneity

Heterogeneity was assessed by inspection of a graphical display of the estimated treatment effects from the trials along with their 95% CI and by Cochran's test for homogeneity undertaken before each meta-analysis. Subgroup analyses were undertaken for assessments based on full-mouth recording versus those based on a partial recording and to examine the effects of concealed allocation, randomisation generation and blind outcome assessment on the overall estimates of effect for important outcomes.

Cross-over trials

It was planned to combine the data from cross-over trials with that of similar parallel group trials, using the techniques described by Elbourne et al (Elbourne 2002). Due to insufficient data this was not possible.

Investigation of publication and other biases

A funnel plot (plots of effect estimates versus the inverse of their standard errors) was drawn. Asymmetry of the funnel plot may indicate publication bias and other biases related to sample size, though it may also represent a true relationship between trial size and effect size. A formal investigation of the degree of asymmetry was performed using the method proposed by Egger et al (Egger 1997). A further method proposed by Begg and Mazumdar which tests for publication bias by determining if there is a significant correlation between the effect estimates and their variances was also carried out (Begg 1994). Both methods were carried out using Stata version 7.0 (Stata Corporation, USA) using the program Metabias.

DESCRIPTION OF STUDIES

The search identified 354 trials of which 139 were considered to be ineligible from the information provided in the title or abstract. Full articles were obtained for the remaining 215. From the full articles 152 trials proved ineligible. From the abstracts and full articles 29 trials had insufficient detail to be able to convincingly allocate them to the category of included or excluded trials. Thirty-six trials were eligible. Of these eligible trials, five cross-over and two parallel trials provided insufficient information for the data to be used in a meta-analysis, and were excluded. Twenty-nine trials fulfilled all inclusion criteria and had results that could be entered for meta-analysis.

The authors of 36 trials with insufficient information were contacted and asked to provide the missing details required to include or exclude the data.

One reason for the exclusion of each study is given in the 'Characteristics of excluded studies' table. Many trials were ineligible for more than one reason. Trials or abstracts which proved to be duplicates of included studies are tabulated here, but entered in the included study references list, as such. For trials where authors had been contacted for further information and where no reply was received after 3 months, the study was considered ineligible for insufficient data available. Should the required data be supplied such trials will be addressed in the next review. A summary of the reasons for exclusion is given in 'Additional Table 01'.

Of the 29 included trials, 21 were conducted in North America (Lobene 1964a; Soparkar 1964; Glass 1965; Baab 1989; Walsh 1989; Emling 1991; Khocht 1992; Barnes 1993; Wilson 1993; Yukna 1993b; Johnson 1994; Terezhalmy 1995a; O'Beirne 1996; Tritten 1996; Yankell 1996; Ho 1997 ; Yankell 1997; Cronin 1998; Forgas-B 1998; Warren 2001; Dentino unpublished); seven in Europe (McAllan 1976; Stoltze 1994; van der Weijden 1994; Ainamo 1997; Clerehugh 1998; Heasman 1999a; Lazarescu unpublish) and one in Israel (Stabholz 1996).

Two trials were unpublished. The remainder were published between 1964 and 2001; three in the 1960s; one in the 1970s; two in the 1980s; 20 in the 1990s and one in the 2000s. At least 19 were funded in some part by the manufacturer of one of the powered toothbrushes, the remainder were unclear about sponsorship.

The combined total number of participants included in the trials was 2547. The number of patients reported lost to follow up was 239 (9.4%).

CHARACTERISTICS OF PARTICIPANTS

For each study the inclusion criteria are noted in the 'Characteristics of included studies' table and in 'Additional Table 02'. Out of the 29 eligible trials the four most frequently stated inclusion criteria were adults (66% of trials), no relevant medical history (72%), a stated minimal number of teeth required (59%) and at least a minimal gingival, periodontal or plaque pre-treatment measure (55%). Exclusion criteria for included trials were noted and summarised in 'Additional Table 03'.

CHARACTERISTICS OF INTERVENTIONS

The powered toothbrushes, included:

Braun, Interplak, Braun Plaque Remover with OD5 head, Braun Oral B 3D, Braun Oral B D9, PlaK Trac, Ultrasonex, GEC, Braun Oral B D7, Phillips Jordan HP 735, Sonicare ultrasonic, Philips Sonicare, Epident, Braun Oral B D5, Philips 550, Touchtronic Teledyne Aqua Tec, Ronson, Dominion, Pulse Plaque Remover, Broxodent, Plaq and White, LPA/Broxo, Braun D17, Rowenta Dentiphant, Rowenta , Plaque

Dentacontrol Plus. These are summarised in 'Additional Table 04'.

Powered toothbrush, mode of action.
The powered toothbrushes were subdivided into six groups according to their mode of action.

Side to side action.
Philips Sonicare and Sonicare brushes (Sonicare c/o Philips Oral Healthcare, 35301 SE Center Street, Snoqualmie, WA 98065; http://www.sonicare.com/);
Philips 550 (Phillips Jordan, P.O. Box 324, 5500 AH Veldhoven, The Netherlands; http://www.philips-jordan.com/).

Counter oscillation.
Interplak brush (Interplak Conair Corporation, I Cummings Point Road, Stamford, CT 06904 http://www.conair.com/products/).

Rotation oscillation.
Braun Oral B 3D, D17, Plaque Remover with OD5 head, Oral B D9, Oral B D7, Oral B D5 (Braun Oral-B Consumer Services, 1Gillette Park, South Boston, MA; http://www.oralb.com/);
Phillips Jordan HP 735 (Phillips Jordan P.O. Box 324, 5500 AH Veldhoven, The Netherlands; http://www.philips-jordan.com/).

Circular.
Rowenta Dentiphant, Rowenta, Plaque Dentacontrol Plus (Rowenta Werke GmbH, Franz Alban, Stützer, Germany; (http://www.products.rowenta.de/row/index.html);
Teledyne Aqua Tech brushes (Corporate Headquarters 12333 West Olympic Boulevard Los Angeles, CA 90064; http://www.waterpik.com/oralhealth/).

Ultrasonic.
Ultrasonex brush (Salton-Maxim 1801 N. Stadium Boulevard, Columbia, MO 65202; http://www.salton-maxim.com/salton/ultrasonex/ultrasonex.asp).

The names and addresses of the manufacturers have changed over the years and those quoted above are correct at the time of the present review. Some of the trials were conducted when another company made the powered toothbrush. Some companies are no longer operational or complete details of their toothbrushes reported on are not easily found. The following toothbrushes fall into this latter category: PlaK Trac, GEC, Epident, Touchtronic, Ronson, Dominion, Broxodent, Plaq and White, LPA/Broxo.

Eight trials including 627 participants at the end of the trial compared manual brushing versus side to side powered toothbrushing. Four trials provided data on 184 participants at the end of the trial compared manual brushing versus counter oscillating toothbrushing. Ten trials with 867 participants at the end of the trial compared manual brushing versus rotation oscillation powered brushing. Three trials including 168 participants at the end of the trial compared manual brushing versus circular powered brushing and two trials of 108 participants at the end of the trial compared manual brushing versus ultrasonic powered brushing. Two trials with 295 participants at the end of the trial compared manual brushing and a powered toothbrush with an unknown action.

Summary of trials by tooth brush action
The trials that compared manual with a side to side action powered brush were: (Glass 1965; Johnson 1994; Tritten 1996; Yankell 1997; Ho 1997; Lobene 1964a; Walsh 1989; O'Beirne 1996). Counter oscillation: (Khocht 1992; Stabholz 1996 (not included in meta-analysis); Wilson 1993; Yukna 1993b; Baab 1989). Rotation oscillation: (Barnes 1993; Cronin 1998; Dentino unpublished; Heasman 1999; Ainamo 1997; Clerehugh 1998; Stoltze 1994; van der Weijden 1994; Warren 2001; Yankell 1997Lazarescu unpublish). Circular: (Khocht 1992; McAllan 1976; Yankell 1996). Ultrasonic: (Forgas-B 1998; Terezhalmy 1995a) and unknown (Emling 1991; Soparkar 1964).

CHARACTERISTICS OF OUTCOME MEASURES
Twenty-six trials (1787 participants at the end of the trial) reported plaque at 1 to 3 months and 10 trials (796 participants at the end of the trial) at longer than 3 months. Twenty-nine (2307 participants at the end of the trial) reported gingivitis at 1 to 3 months and 10 (796 participants at the end of the trial) at greater than 3 months.

Sixteen trials recorded whole mouth scores for plaque and gingivitis; seven trials recorded part mouth scores for both variables. One trial recorded part mouth scores for plaque and whole mouth scores for gingivitis and four trials recorded whole mouth scores for plaque and part mouth scores for gingivitis.

METHODOLOGICAL QUALITY

The agreement between the reviewers was generally good with kappa values for adequacy of allocation concealment 0.49, adequate outcome assessor blinding 0.72, adequacy of reporting and handling of attrition 0.70 and mention of manufacturer funding 1.00.

SELECTION BIAS
The generation of randomisation sequence was adequate for two (6.9%) of the 29 trials, and unclear for 27 trials (93.1%). The concealment of allocation was adequate for 10 trials (34.5%), unclear for 17 (58.6%) and inadequate for two (6.9%).

DETECTION BIAS
The outcome assessor was adequately blinded in 26 trials (89.7%). The adequacy of blinding was unclear in two trials (6.9%). Blinding was not reported in one trial (3.4%).

ATTRITION BIAS
Withdrawals were adequately reported in 22 trials (76%) and inadequately reported in seven (24%).

The reported drop out rate was 9.4%. Trials with follow up of less than 3 months had a drop out rate of 5.3%. Trials with follow up of greater than 3 months had a drop out rate of 13.2%.

SPONSORSHIP
Funding by a manufacturer of one of the brushes under investigation was stated in 22 (76%) of the trials and unclear in seven (24%).

RESULTS

As mentioned earlier in the data synthesis section of the methods of the review, the differences in plaque and gingivitis reduction between the powered and manual brushes were expressed as standardised mean differences (SMDs) for both short term and long term studies. Significant differences in SMDs are reported below. To improve the appreciation of clinical significance, SMDs have also been converted to equivalent values in commonly used plaque and gingivitis indices.

SIDE TO SIDE POWERED TOOTHBRUSHES ('Comparison 01' 'Outcomes 01-04')
There were six trials comparing side to side powered brushes included in the meta-analysis for 1 to 3 month plaque, eight for 1 to 3 month gingivitis and only two trials included in both the meta-analyses for measures after 3 months. There was no statistically significant difference between powered toothbrushes whose action was side to side and manual brushes with regard to the removal of plaque or reduction of gingivitis for both time periods.

COUNTER OSCILLATION POWERED TOOTHBRUSHES VERSUS MANUAL ('Comparison 02' 'Outcomes 01-04')
There were four trials included in the meta-analysis for 1 to 3 month plaque, four for 1 to 3 month gingivitis and only two trials included in both the meta-analyses for measures after 3 months. There was no evidence that powered toothbrushes whose action was counter oscillation were more effective than manual brushes for the removal of plaque or reduction of gingivitis with the exception of being associated with less plaque in the long term, where the SMD was -0.63 (95% confidence interval (CI): -1.11, -0.14).

ROTATIONAL OSCILLATION POWERED TOOTHBRUSHES VERSUS MANUAL ('Comparison 03' 'Outcomes 01-04')
This comparison contained the greatest number of trials, with 10 trials included in both the meta-analyses for early plaque and gingivitis, and four trials included in the long term comparisons. Brushes that worked with a rotation oscillation action removed more plaque and reduced gingivitis more effectively than manual brushes in both the short and long term. For plaque at 1 to 3 months the SMD was -0.44 (95% CI: -0.66, -0.21), for gingivitis SMD -0.45 (95% CI: -0.76, -0.15). These differences converted to a reduction of 0.20 or 11% on the Quigley Hein plaque index and a reduction of 0.09 or 6% on the Löe and Silness gingival index. At over 3 months the effects were SMD for plaque -1.15 (95% CI: -2.02, -0.29) and SMD for gingivitis -0.51 (-0.76, -0.25). These differences converted to a reduction of 0.5 or 7% for the Quigley Hein plaque index and a 0.04 or 17% reduction on the Ainamo Bay bleeding on probing index. There was considerable heterogeneity between the trials in the meta-analyses for the short term follow up, which is reported later in this section.

CIRCULAR POWERED TOOTHBRUSHES VERSUS MANUAL ('Comparison 04' 'Outcomes 01-04')
Three trials were included in both these analyses for early plaque and gingivitis evaluation, and only one trial in each of the meta-analyses for longer follow up. There was no evidence that brushes with a circular action removed plaque or reduced gingivitis more effectively than manual brushes in either time period.

ULTRASONIC TOOTHBRUSHES VERSUS MANUAL ('Comparison 05' 'Outcomes 01-02')
There were only two trials for each of the meta-analyses for the short term assessments of plaque and gingivitis, and one trial in both long term meta-analyses. The short term comparison between ultrasonic and manual brushes reached borderline statistical significance for plaque removal with SMD -0.45 (-0.90, 0.00). No other statistically significant differences were noted between manual and ultrasonic brushes.

INVESTIGATION OF HETEROGENEITY
The heterogeneity in the short term meta-analyses comparing rotation oscillation powered and manual brushing for both plaque and gingivitis was caused by one study with exceptionally low standard deviations for all indices (Stoltze 1994).

SENSITIVITY ANALYSES
Sensitivity analyses were conducted for trials: where a full mouth index had been used, where adequate concealment of randomisation occurred, where there was adequate generation of randomisation sequence, with blinding of the outcome assessor, mentioning no commercial funding, with adequate information about attrition, with comparable brushing instruction given to all groups and for trials that were not restricted to participants only wearing fixed orthodontic appliances. These analyses were limited to the meta-analyses for rotational oscillation powered toothbrushes versus manual ('Comparison 03' 'Outcomes 01 and 02') which showed significant effects and contained the greatest number of trials. The revised meta-analyses yielded similar effect estimates to the overall estimates, indicating that the results are robust and not distorted by the lesser quality trials. ('Additional Table 05').

PUBLICATION BIAS
Publication bias was assessed for the meta-analyses for rotational oscillation powered toothbrushes versus manual for the 1 to 3 month assessments. The funnel plots for each appeared symmetric with no evidence of bias for either plaque or gingivitis using the Egger (weighted regression) method (p = 0.78, 0.52 respectively), or using the Begg (rank correlation) method (p = 0.72, 0.41).

SECONDARY OUTCOMES

Cost

None of the included trials reported on the relative costs of manual compared with powered toothbrushes.

Reliability

One trial reported a mechanical failure of one of the 48 powered toothbrushes used (Clerehugh 1998) and one trial reported mechanical failure in four of 20 powered brushes (Yukna 1993b). No other mechanical failures were reported.

Calculus

Three trials (Dentino unpublished; Glass 1965; van der Weijden 1994) reported on calculus, two reporting that there was no significant difference between the brush types (van der Weijden 1994; Glass 1965) and one reporting that, compared to the manual brush, the powered brush group showed a significant favourable difference in the accumulation of calculus at 6 months p = 0.0078 (Dentino unpublished).

Stain

Three trials reported that there was no difference in the degree of staining on the teeth between the brush types (Dentino unpublished; Glass 1965; Walsh 1989).

Soft tissue trauma

Eighteen trials reported on soft tissue side effects. Ten trials reported no soft tissue side effects for any of the brush types under investigation. Five trials reported no difference in soft tissue effects between the brush types. Three trials reported a difference in soft tissue trauma between the brushes used. Of these one reported five cases of gingival abrasion in the manual and one case of abrasion in the powered group (Tritten 1996), another reported 12 cases of gingival abrasion in the manual and five cases of gingival abrasion in the powered group (van der Weijden 1994). One trial reported seven soft tissue abnormalities in six participants in the manual group and 10 abnormalities in seven participants in the powered group (Johnson 1994).

DISCUSSION

We brush our teeth for many reasons: to feel fresh and confident; to have a nice smile; to avoid bad breath and to avoid disease. The selection of one's toothbrush is largely a matter of personal preference, affordability, availability and professional recommendation. Powered toothbrushes may have a particular appeal to some because they represent a newer 'high tech' solution to an everyday task.

This systematic review has found that powered toothbrushes with a rotation oscillation action removed plaque and reduced gingivitis more than manual brushes in both the long and short term. Other forms of powered brushes produced a less consistent reduction of plaque and gingivitis.

Few data were reported on the costs or reliability of the brushes or the side effects of their use. When reported, injuries to the gums were minor and transient. Randomised controlled trials may not be the best research design for investigating these adverse outcomes. Expert groups have suggested that powered toothbrushes are safe if used correctly but further research is required in these areas (Lang 1998).

There is overwhelming evidence that toothbrushing reduces gingivitis (Lang 1973). It may prevent periodontitis and certainly prevents tooth decay if carried out in conjunction with fluoride toothpaste. These benefits occur whether the brush is manual or powered and the results of this review do not indicate that toothbrushing is only worthwhile with a powered toothbrush.

As mentioned in the results section, standardised mean differences (SMDs) may be converted to the corresponding values of particular clinical indices. The plaque scores in short term trials of rotation oscillation brushes was -0.44. Using this level of effectiveness as an example, in the trial by Cronin (Cronin 1998) a similar standardised mean difference (-0.45) corresponded to a mean difference in the Turesky modification of the Quigley Hein index of 0.27. The mean plaque score among those using manual brushes in the trial by Cronin was 2.55 and thus the difference is 11%.

For gingival scores the SMD in short term trials of rotation oscillation brushes was -0.45. Again, using this level of effectiveness, in the trial by Heasman (Heasman 1999) the SMD of -0.42 corresponded to a mean difference in the Löe and Sillness gingival index of 0.09. The mean gingival index score for those using manual brushes in the trial was 1.64 and thus the difference is 6%.

The same approach can be used to assess the effect of rotation oscillation powered toothbrushes on long term reductions in plaque and gingivitis, and indicates benefits of 7% and 17% respectively. Had a weighted mean difference method been used for pooling the data rather than a standardised mean difference, similar results and conclusions would have been reached .

This raises the question, what level of plaque removal and reduction in gingivitis will result in clinically significant improvements in oral health?

The results of the review can be related to destructive periodontal disease (periodontitis) only with some difficulty. Some authorities have advocated the use of arbitrary thresholds to make superiority claims for a specific product. For example, Imrey has proposed that a product cannot be claimed to be superior unless it provides a 20% improvement in performance (not the case for any types of brush in this review, in terms of long term plaque removal) (Imrey 1992; Imrey 1994). However, other authors have criticised the use of arbitrary thresholds and prefer a threshold for clinical significance to be decided in advance and selected on clinical grounds (D'Agostino 1992).

Many factors are associated with the occurrence of periodontitis including plaque, tobacco use and individual medical factors. Periodontitis takes many years to develop and the trials have

much shorter follow up. The evidence that plaque and gingivitis are reliable proxies for long term destructive disease is not compelling and it is difficult to estimate a clinical threshold for significant plaque reduction. We conclude that rotation oscillation brushes provide reductions for plaque removal but the clinical significance of these reductions cannot be assessed.

The apparent significant long term effects of counter oscillational brushes on plaque may be a spurious finding. It was the only outcome associated with the use of these brushes out of four studied.

One possible weakness of this review was the grouping of toothbrushes by their modes of action. Whilst this approach allowed more powerful meta-analysis it is possible that toothbrushes whose actions had subtle differences were more or less effective. Similarly, so many factors may influence the effectiveness of toothbrushes including filament arrangement, orientation, size, shape and flexibility, brush head size and shape along with presence or absence and characteristics of a timer, that not all of them could be isolated and analysed. Whether the brush has a battery or rechargable power source may also be important.

Publication bias seems likely to be present in the reporting of these trials as manufacturers would like to have scientific support for the effectiveness of their powered toothbrushes. However there was no evidence of this when publication bias was examined statistically, and no evidence of a difference in effect estimates when a sensitivity analysis was conducted for trials which did not mention commercial funding. It should be noted that the methods for detecting publication bias are relating effect size to sample size, and in this review the trials tend to be of similar size. Therefore other methods may be required to examine publication bias in short term, low cost studies.

Five eligible cross-over trials had to be excluded from the review as the data presented did not include the standard deviation of the paired differences, or alternative statistics which would enable this value to be estimated (Elbourne 2002). Attempts were made to contact all the trialists however they were unable to supply the necessary data. It is important that trialists analyse the data from cross-over trials appropriately and present relevant data in reports of trials.

REVIEWER'S CONCLUSIONS

Implications for practice

This review has found that compared with manual toothbrushes, powered toothbrushes whose action is rotation oscillational reduce plaque and gingivitis by 7 and 17% respectively at greater than 3 months. The clinical significance of these reductions is not known.

The trials available for the review were too short term to demonstrate whether these effects achieve a reduction in destructive periodontal disease.

Individuals who prefer the 'feel' of using a powered toothbrush can be assured that powered toothbrushing is at least as effective as manual brushing and that there is no evidence that it will cause any more injuries to the gums than manual brushing.

As none of the trials we found compared the durability, reliability and cost of using manual versus powered brushes, it is presently not possible to make a clear recommendation on toothbrush superiority.

Implications for research

Trials of longer duration are required to fully evaluate powered toothbrushes. There are few adequate trials reporting over more than 3 months. Data on the long term benefits of powered toothbrushes would be valuable in their own right and could be used to trial other outcomes such as the adverse effects and benefits in the prevention of periodontitis and dental caries. Moreover, more trials would lend greater power to systematic reviews of the effectiveness of powered toothbrushes.

The review revealed many idiosyncrasies in the design of the trials, in some cases data could not be included in this review. Whilst many of the trials were conducted before the current emphasis on experimental design, even the most recent trials lacked power calculations and had not been analysed on an intention to treat basis. Researchers in this field would be advised to study guidance on the design and reporting of clinical trials such as that provided in the CONSORT statement (http://www.consort-statement.org/).

Specific guidance exists for trials in the treatment or prevention of periodontal diseases (Imrey 1994) but greater standardisation of both the follow-up intervals and the indices used would benefit both trials and future meta-analyses. Thought should also be given to when the mouth should be examined in relation to when the teeth were last cleaned.

Some research designs created an artificial research environment that may have undermined the generalisability of the findings. In particular the external validity was questionable in trials with split mouth designs where participants are asked to clean each side of their mouth with a different brush, in trials where interventions where used in combination and those where toothbrushing was supervised. Hence their exclusion from this meta-analysis.

More research with improved rigour is also needed on the relative benefits of powered and manual toothbrushes to prevent or remove extrinsic staining of the teeth and calculus.

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POTENTIAL CONFLICT OF INTEREST

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SYNOPSIS

Powered toothbrushes with a rotation oscillation action provide slightly better plaque removal and may provide better protection against gum inflammation than manual toothbrushes

Removing dental plaque by toothbrushing with a fluoride toothpaste helps prevent gum inflammation (gingivitis) and tooth decay. The latter may be largely due to the fluoride. Powered toothbrushes simulate manual toothbrushing in different ways (such as moving side to side or circular motions). The review of trials found that only rotation oscillation (where brush heads rotate in one direction and then the other) is better than manual toothbrushes at removing plaque and reducing gum inflammation, and is no more likely to cause injuries to gums. Long term benefits of this for dental health are unclear.

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** Indicates the major publication for the study*

TABLES

Characteristics of included studies

Study	**Ainamo 1997**
Methods	RCT, parallel, single blind, 12 months, n 112 with 1 drop out.
Participants	Finland, adults, 20-63 years, 64M:47F, bleeding on probing > 30% sites, no medical problems.
Interventions	Braun Oral B Plak Control versus Jordan soft, 2 mins twice daily.
Outcomes	Ainamo and Bay Visible Plaque Index and modified gingival bleeding index. 3, 6 and 12 months. Whole mouth recording PI and GI.
Notes	No pre-examination instructions reported.
Allocation concealment	B

Study	**Baab 1989**
Methods	RCT, parallel, single blind, 1 month, n 41, with 1 drop out.
Participants	USA, adults, 18-59 years, 24M 16F, > 20 teeth with moderate gingivitis, no medical problems.
Interventions	Interplak versus Butler 411, 3 mins twice daily.
Outcomes	O'Leary plaque index, Löe and Silness gingival index, Ainamo and Bay gingival bleeding index. Ramfjord teeth for GI, whole mouth for PI. Gingival abrasion reported to be not significant. Plaque scores awaiting assessment.
Notes	Manufacturer funded. No pre-examination instructions reported.
Allocation concealment	B

Study	**Barnes 1993**
Methods	RCT, parallel, single blind, 3 months, n 70 with 1 drop out.
Participants	USA, adults, 18-65 years, > 20 teeth, gingival index > 1.5, plaque index > 2.
Interventions	Braun Oral B Plaque Remover versus Johnson & Johnson Reach, as per normal use.
Outcomes	Quigley and Hein (Turesky) Plaque Index, Löe and Silness (Lobene) gingival index at full mouth sites. Soft tissue trauma, no difference between brushes. Whole mouth recording PI and GI.
Notes	Manufacturer funded. No pre-examination instructions reported.
Allocation concealment	B

Study	**Clerehugh 1998**
Methods	RCT, parallel, single blind, 8 weeks, n 84 with 5 drop outs.
Participants	UK, children and adolescents, 10-20 years, orthodontic patients in practice, fixed appliances, gingival bleeding at 30% sites, no medical conditions.

Characteristics of included studies

Interventions	Braun Plaque Remover with OD 5 head versus Reach medium compact head, 2 mins twice daily.
Outcomes	Orthodontic modification of Silness and Löe plaque index, Eastman bleeding index at all buccal sites at 4,8 weeks. No evidence of trauma. One mechanical brush failed.
Notes	Manufacturer funded. Participants asked to brush in the morning and under supervision prior to assessment.
Allocation concealment	A

Study	**Cronin 1998**
Methods	RCT, parallel, single blind, 3 months, n 114, 9 drop outs unclear.
Participants	USA, adults, > 18 teeth, no medical problems, 18-65 years.
Interventions	Braun Oral B 3D Plaque remover versus standard ADA reference manual, 2 mins twice daily.
Outcomes	Quigley and Hein (Turesky) plaque index, Löe and Silness gingivitis and bleeding index, at 14, 35 and 90 days, at all sites. Gingival recession recorded, no change seen. No other adverse effects. Whole mouth recording PI and GI.
Notes	Manufacturer funded. Participants asked to refrain from brushing 12-14 hours prior to assessment.
Allocation concealment	A

Study	**Dentino unpublished**
Methods	RCT, parallel, single blind, 6 months, n 172 with 15 drop outs.
Participants	USA, adults, mild to moderate gingivitis with > 20 teeth, no previous powered brush experience. Excluded if pregnant/lactating.
Interventions	Braun Oral B D9 vs ADA accepted standard soft bristle manual, 2 mins twice daily.
Outcomes	Quigley and Hein (Turesky) Plaque index and Lobene gingival index at 3 and 6 months. Powered brush removed more calculus. No difference in stain removal reported. PI and GI whole mouth.
Notes	Manufacturer funded. Participants asked to brush teeth (non-supervised) immediately prior to 6 month plaque assessment.
Allocation concealment	A

Study	**Emling 1991**
Methods	RCT, parallel, single blind, 30 days, n 60 with 3 drop outs.
Participants	USA, adults, no medical problems, no current ortho, not pregnant, > 17 teeth, 18 to 60 years.
Interventions	Plak trac versus Colgate ADA approved, twice daily.
Outcomes	Quigley Hein (Turesky) Plaque index. Yankell, interproximal plaque index, Löe and Sillness gingival index. Ramfjord teeth for both PI and GI.

Characteristics of included studies

Notes	Pre-brushing measurements used.
Allocation concealment	B
Study	**Forgas-B 1998**
Methods	RCT, parallel, single blind, 30 days, n 62 with 6 drop outs.
Participants	USA, adults, mean age 37 years +/- 10 years, > 16 teeth, plaque index > 2, no medical problems, 21M: 35F.
Interventions	Ultrasonex versus manual Oral B, twice daily.
Outcomes	Quigley and Hein (Turesky) Plaque index, Eastman gingival bleeding index at 30 days. Ramfjord teeth for PI and GI. Soft tissue trauma reported, no difference between groups.
Notes	Manufacturer funded. Participants asked to refrain from brushing for 12-14 hours before assessment.
Allocation concealment	B
Study	**Glass 1965**
Methods	RCT, parallel, single blind, 11 months, n 250 with 84 drop outs.
Participants	USA, dental students, male, 20-29 years.
Interventions	GEC powered versus Pycopay brand manual twice daily.
Outcomes	Glass debris and gingival indices at 6 weeks, 7 and 11 months at all sites. Stain and calculus reported to be no different between brush types. Whole mouth recording PI and GI. No soft tissue trauma reported.
Notes	Manufacturer funded. No pre-examination instructions reported.
Allocation concealment	B
Study	**Heasman 1999**
Methods	RCT, parallel, single blind, 6 weeks, n 75 with 1 drop out.
Participants	UK, adult, > permanent 20 teeth, 18-25 years, no medical problems.
Interventions	Braun Oral B D7 versus Philips Jordan HP 735 versus Oral B Advantage B35, > 90 secs twice daily.
Outcomes	Quigley and Hein (Turesky) plaque index at 24 hours and 6 weeks, Löe and Silness gingival index at 6 weeks, all sites. Whole mouth recording PI and GI.
Notes	Assessment done within 3-4 hours of last brushing. Two powered groups combined for meta-analysis.
Allocation concealment	B
Study	**Ho 1997**
Methods	RCT, parallel, single blind, 4 weeks, n 24, drop outs unclear.

Characteristics of included studies

Participants	USA, orthodontic patients, with fixed appliances, 11-18 years, gingival index > 2, no medical conditions.
Interventions	Sonicare ultrasonic versus Oral B P35, 2 mins twice daily.
Outcomes	Silness and Löe gingival and plaque indices on 6 sites per bonded tooth and bleeding on probing all at 4 weeks. Whole mouth recording PI and GI.
Notes	Manufacturer funded. No pre-examination instructions reported.
Allocation concealment	A

Study	**Johnson 1994**
Methods	RCT, parallel, single blind, 4 weeks, n 51 with 8 drop outs.
Participants	USA, adult, > 20 teeth, gingival index > 1.5 on Ramjford teeth, no medical conditions, 20-54 years.
Interventions	Philips sonicare versus Oral B 30, 2 mins twice daily.
Outcomes	Quigley and Hein (Turesky) on all sites, Ainamo and Bay gingival index and sulcular bleeding indices on Ramfjord at 1, 2, 4 weeks. Soft tissue trauma "abnormalities" 7 sites in 6 subjects for manual and 10 sites in 7 subjects for powered.
Notes	Manufacturer funded. Post brushing evaluation.
Allocation concealment	B

Study	**Khocht 1992**
Methods	RCT, parallel, single blind, 4 weeks, n 96 with 1 drop out.
Participants	USA, adults, > 15 teeth with no restorations affecting cervical region plaque score > 1.8 and gingival score > 0.9, no medical conditions.
Interventions	Epident versus Oral B 40, twice daily.
Outcomes	Quigley and Hein (Turesky) Plaque index and Loe and Silness gingivitis index at all sites at 28 days. Whole mouth recording for PI and GI. No reported soft tissue abrasion.
Notes	Manufacturer funded. Pre-brushing evaluation. Epident group (experimental brush) excluded from meta-analysis (n=32).
Allocation concealment	B

Study	**Lazarescu unpublish**
Methods	RCT, parallel, single blind, 18 weeks, n 80 with 2 drop outs.
Participants	Romania, adults, > 20 teeth, medically fit and no previous powered brush experience.
Interventions	Philips/Jordan HP 735 versus Oral B 40 manual with normal brushing pattern.
Outcomes	Quigley and Hein (Turesky) Plaque index at 6 sites per tooth and gingival bleeding index at proximal smooth surfaces at 18 weeks. Whole mouth recording PI and GI.

Characteristics of included studies

Notes	Manufacturer funded. Assumed pre-brushing evaluation.
Allocation concealment	A
Study	**Lobene 1964a**
Methods	RCT, parallel, single blind, n 185, 3 months, drop outs unclear.
Participants	USA, female college students, aged 17-21 years.
Interventions	General electric reciprocating action versus Oral B 40 manual with no instruction.
Outcomes	Lobene Gingivitis index at 3 months. Whole mouth recording PI and GI.
Notes	Manufacturer funded. No pre-examination instructions reported.
Allocation concealment	A
Study	**McAllan 1976**
Methods	RCT, parallel, no blinding, 6 months, n 55 with 15 drop outs.
Participants	UK, children and adolescents attending paediatric department, 9-15 years, 24M 31F.
Interventions	Touchtronic Teledyne Aqua Tec versus Gibbs short head manual.
Outcomes	Silness and Löe plaque whole mouth and Löe and Silness gingival indices at first molars and lateral incisor teeth at 1, 2 and 6 months.
Notes	Manufacturer funded. No pre-examination instructions reported.
Allocation concealment	C
Study	**O'Beirne 1996**
Methods	RCT, parallel, single blind, n 40, 8 weeks, drop outs unclear.
Participants	USA, adults with inflammatory periodontal disease, > 20 teeth and received periodontal treatment, 22M 18F, 18-65 years.
Interventions	Sonicare Ultrasonex versus Oral B manual 2 mins twice daily.
Outcomes	Löe and Silness gingival index, Barnett papillary bleeding index at 2, 4 and 8 weeks, at all sites. Whole mouth recording PI and GI. Minor gingival trauma seen in one participant in each group.
Notes	Part funded by manufacturer.
Allocation concealment	A
Study	**Soparkar 1964**
Methods	RCT, parallel, single blinded, 11 weeks, n 270 with 32 drop outs.
Participants	USA, college students non-dental.
Interventions	Unknown action powered versus manual with normal regime.
Outcomes	Quigley and Hein gingival index at 11 weeks. Anterior teeth only.

Characteristics of included studies

Notes	No pre-examination instructions reported.
Allocation concealment	B
Study	**Stabholz 1996**
Methods	RCT, parallel, single blinded, n 56 with 4 drop outs, 60 days.
Participants	Israel, general population, no medical conditions.
Interventions	Plaq and White A to Z technology versus Oral B 35 as per normal regime.
Outcomes	Quigley and Hein (Turesky) and Löe and Silness gingival and Eastman BOP indices on Ramfjord teeth at 15 and 30 days. No difference in soft tissue trauma between brush types.
Notes	Participants asked to refrain from brushing for 12 hours prior to each assessment.
Allocation concealment	B
Study	**Stoltze 1994**
Methods	RCT, parallel, unclear blinding method used, n 40 with 2 drop outs, 6 weeks.
Participants	Denmark, young adults 18-30 years, with plaque and gingival scores > 1, > 20 teeth, no medical problems.
Interventions	Braun Oral B Plak Control D5 versus Tandex 40 manual, 2 mins twice daily.
Outcomes	Silness and Löe plaque index, Löe and Silness gingival index at all sites, 1, 2 and 6 weeks. Whole mouth recording PI and GI. No gingival abrasion reported.
Notes	No pre-examination instructions reported.
Allocation concealment	B
Study	**Terezhalmy 1995a**
Methods	RCT, parallel, single blind, 6 months, n 60 with 14 drop outs.
Participants	USA, adults, good health and free of oral pathology.
Interventions	Ultra-sonex ultrasonic versus Oral B manual 3 min twice daily.
Outcomes	Quigley and Hein (Turesky) plaque index and Löe and Silness gingival index at all sites and Eastman Bleeding on Probing index on contralateral Ramjford teeth. Assessed at 15 and 30 days and 6 months. No soft tissue trauma.
Notes	Participants asked to refrain from brushing 12-14 hours prior to assessment.
Allocation concealment	B
Study	**Tritten 1996**
Methods	RCT, parallel, single blind, 12 weeks, n 60 with 4 drop outs.
Participants	USA, adults 18-65 years, dental hospital patients, no professional cleaning previous 3 months, minimum 20 teeth, no previous periodontal treatment and unaware of active pregnancy.
Interventions	Sonicare versus Butler 311, 2 minutes twice daily.

Characteristics of included studies

Outcomes	Quigley and Hein (Turesky) plaque index all teeth, Löe and Silness gingival index Ramfjord teeth. Gingival abrasion seen in five manual and one powered brush subjects.
Notes	Manufacturer funded. Pre-brushing evaluation.
Allocation concealment	A

Study	**Walsh 1989**
Methods	RCT, parallel, single blind, n 108, 6 months, drop outs unclear.
Participants	USA, adults from University and Dental clinics, 18-65 years, > 20 teeth, no dental/medical problems, gingival index > 1 on six+ sites of 18 sites probed on Ramfjord teeth.
Interventions	LPA/Broxo powered versus Oral B 40 manual, twice daily.
Outcomes	Silness and Löe plaque index on Ramfjord teeth, BOP on Ramfjord teeth at 3, 6 months. No soft tissue changes reported. Stain reported as no difference between brush types.
Notes	No pre-examination instructions reported.
Allocation concealment	C

Study	**Warren 2001**
Methods	RCT, parallel, single blind, 12 weeks, n 110 with 9 drop outs.
Participants	USA, adult volunteers, 18-65 years, > 18 teeth, plaque index > 1.8, non-smokers, with no medical problems.
Interventions	Braun Oral B D 17 versus ADA standard manual, 2 mins twice daily.
Outcomes	Quigley and Hein (Turesky) plaque index, Löe and Silness gingival index and modified Löe and Silness Bleeding index, on all sites at 1, 3 months. Whole mouth recording PI and GI. No soft tissue changes reported.
Notes	Manufacturer funded. Participants asked to refrain from brushing 12-18 hours prior to assessment.
Allocation concealment	A

Study	**Wilson 1993**
Methods	RCT, parallel, single blind, 12 months, n 32 with 3 drop outs.
Participants	USA, adults, 18+ years, minimum 20 teeth, at least 50% tooth surface plaque coverage (O'Leary), bleeding score > 0.75. Barnett-Muhleman Bleeding Index, no medical problems, no orthodontics, no untreated perio or pockets > 6mm.
Interventions	Interplak, Bausch and Lomb versus Butler 311, 3 minutes.
Outcomes	Quigley and Hein (Turesky) plaque index, Barnett Muhleman gingival index on all sites at 1, 2, 6, 9 and 12 months. Whole mouth recording PI and GI. No difference in gingival abrasion found between brush types.
Notes	Participants asked to brush one hour prior to assessment.
Allocation concealment	B

Characteristics of included studies

Study	**Yankell 1996**
Methods	RCT, parallel, single blind, 4 weeks, n 66 with 1 drop out.
Participants	USA, children with 4 of 6 Ramfjord teeth present, no medical problems.
Interventions	Rowenta Dentiphant versus Oral B 20, 1 min twice daily.
Outcomes	Quigley and Hein (Turesky) plaque and Löe and Silness (Lobene) gingival indices on Ramjford teeth at 2 and 4 weeks. No soft tissue changes reported.
Notes	Manufacturer funded. Pre-brushing evaluation.
Allocation concealment	B

Study	**Yankell 1997**
Methods	RCT, parallel, single blind, 30 days, n 128 with 13 drop outs.
Participants	USA, adults, 18-50 years, > 18 teeth, no current orthodontic bands, no medical problems.
Interventions	Rowenta Plaque Dentacontrol Plus versus Sonicare versus Braun Oral B Ultra versus Oral B P35, 2 min twice daily excluded. Rowenta data which was 5 min twice daily.
Outcomes	Quigley and Hein (Turesky) plaque and Eastman bleeding indices on Ramfjord teeth and also Löe and Silness (Lobene) gingival index on whole mouth at 4 weeks. No soft tissue changes reported.
Notes	Rowenta data excluded due to extended brushing period. Particpants asked to refrain from brushing 10-16 hours prior to evaluation.
Allocation concealment	B

Study	**Yukna 1993b**
Methods	RCT, parallel, single blind, 6 months, n 42 with 2 drop outs.
Participants	USA, adults with past periodontal surgical treatment. Excluded if on antibiotics/NSAIDS or orthodontic appliances.
Interventions	Interplak, Bausch and Lomb versus unspecified manual brush.
Outcomes	Quigley and Hein and O'Leary plaque indices, Lobene gingival index and Bleeding on probing. Whole mouth recording PI and GI. 4 of 20 powered brushes had mechanical failure.
Notes	Manufacturer funded.
Allocation concealment	B

Study	**van der Weijden 1994**
Methods	RCT, parallel, single blind, 8 months, n 87 with 10 drop outs.
Participants	Netherlands, non-dental students, bleeding on probing at least 35% of sites and modified gingival index of at least 1, no previous experience of electric toothbrush. Healthy. No ortho. No pockets > 5mm.
Interventions	Braun Plak control versus Butler Gum 311 for 2 mins.

Characteristics of included studies

Outcomes	Silness and Löe plaque index, Lobene gingival index at all sites at 1, 2, 5, 8 mths. Whole mouth recording PI and GI. Twelve manual brush subjects and five powered brush subjects with gingival abrasion. Calculus scored no difference in change between groups.
Notes	Participants asked to brush thouroughly, but not within one hour of assessment.
Allocation concealment	B

Characteristics of excluded studies

Aass 2000	Less than 28 days
Ainamo 1991	Contacted authors for more information, no reply after 3 months
Albers 1988	Less than 28 days
Anaise 1976	Less than 28 days
Andreana 1998	No movement of powered head
Arcenaux 1996	Less than 28 days
Ash 1964	Not RCT
Ash 1967	Contacted authors for more information, no reply after 3 months
Bastos 1995	Not powered versus manual toothbrushing
Borutta 1997	Less than 28 days
Boyd 1989a	Not RCT
Boyd 1989b	Not RCT
Boyd 1997	Less than 28 days
Braccini 1964	Not powered versus manual toothbrushing
Bratel 1991	Potential high for compromised self toothbrushing efficacy
Buchmann 1987	Less than 28 days
Burch 1994	Combined intervention
Chaikin 1965	Less than 28 days
Chasens 1968	Not RCT
Chilton 1962	Split mouth
Ciancio 1990	Less than 28 days
Ciancio 1998	Contacted authors for more information, no reply after 3 months
Cohen 1964	Potential high for compromised self toothbrushing efficacy
Conroy 1965	Less than 28 days
Conroy 1966	Less than 28 days
Coontz 1983	Less than 28 days

Characteristics of excluded studies

Coontz 1985	Less than 28 days
Crawford 1975	Not RCT
Cronin 1996	Not powered versus manual toothbrushing
Cross 1962b	Less than 28 days
Danser 1998	Less than 28 days
Danser 2000	Less than 28 days
Derbyshire 1964	Less than 28 days
Doherty 1998	Not powered versus manual toothbrushing
Doherty 1999	Less than 28 days
Doll 1999	Less than 28 days
Dorfer 2001	Less than 28 days
Dunkin 1975	Less than 28 days
Elliott 1963	Less than 28 days
Fourel 1974	Split mouth
Fraleigh 1965	Split mouth
Galgut 1996	No mechanical action of brush head
Glavind 1986	Not RCT
Golden 1964	Not powered versus manual toothbrushing
Goldman 1975	Less than 28 days
Grossman 1994	Less than 28 days
Grossman 1996	Less than 28 days
Grossman 1997	Not powered versus manual toothbrushing
Haffajee 2001a	Contacted authors for more information, no reply after 3 months
Haffajee 2001b	Outcomes not under consideration
Hall 1971	Potential high for compromised self toothbrushing efficacy
Hansen 1999	Laboratory study
Heasman 1998	Not RCT inadequate control
Hefti 2000	Not powered versus manual toothbrushing
Heintze 1996	Combined intervention
Hellstadius 1998	Not powered versus manual toothbrushing
Hirsch 1965	Laboratory study
Hoover 1962	Less than 28 days
Horowitz 1992	Not RCT
Hotta 1992	Less than 28 days

Characteristics of excluded studies

Howorko 1993	Less than 28 days
Isaacs 1999	Contacted authors for more information, no reply after 3 months
Jackson 1991	Not RCT
Jonganelis 1997	Less than 28 days
Kambhu 1993	Potential high for compromised self toothbrushing efficacy
Kaschny 1999	Not RCT
Killoy 1989	Contacted authors for more information, no reply after 3 months
Killoy 1998	Contacted authors for more information, no reply after 3 months
Lamendola-Sita 1998	No mechanical action of brush head
Lange 1978	Less than 28 days
Leftkowitz 1962	Less than 28 days
Lim 1995	Contacted authors for more information, no reply after 3 months
Long 1985	Split mouth
Love 1988	Contacted authors for more information, no reply after 3 months
Love 1993	Combined intervention
Lundergan 1988	Less than 28 days
Manhold 1965	Outcomes not under consideration
Mantokoudis 2001	Less than 28 days
Mayer 1978	Less than 28 days
Mayer 1988	Split mouth
McCracken 2000	Not powered versus manual toothbrushing
McInnes 1984	Outcomes not under consideration
McKendrick 1988	Not RCT
Moran 1995	Less than 28 days
Moran 1995b	Less than 28 days
Morris 1997	Contacted authors for more information, no reply after 3 months
Moschen 1999	Less than 28 days
Murray 1989	Outcomes not under consideration
Niemi 1986	Less than 28 days
Niemi 1987	Less than 28 days
Niemi 1988	Less than 28 days
Owen 1972	Cross-over study, contacted authors for more information, no reply after 3 months
Park 1997	Not teeth (e.g. implants, enamel sections on dentures)
Plagmann 1978	Not human

Characteristics of excluded studies

Powers 1967	Less than 28 days
Preber 1991	Less than 28 days
Priestland 1993	Not powered versus manual toothbrushing
Quigley 1962	Less than 28 days
Quirynen 1994	Split mouth
Rapley 1994	Laboratory study
Rashid 1998	Less than 28 days
Renton-Harper 2001	Less than 28 days
Reynolds 1998	Not powered versus manual toothbrushing
Ruhlman 2001	Less than 28 days
Sato 1995	Less than 28 days
Schiffer 1983	Less than 28 days
Schmage 1999	Supervised or professional cleaning
Schuler 1995	Abstract only
Schwarz 1990	Not powered versus manual toothbrushing
Sgan-Cohen 1995	Not powered versus manual toothbrushing
Shaw 1983	Potential high for compromised self toothbrushing efficacy
Silverstone 1992	Contacted authors for more information, no reply after 3 months
Sjogren 1998	Less than 28 days
Smith 1964	Cross-over study, contacted authors for more information, no reply after 3 months
Stadtler 1984	Less than 28 days
Swenson 1967	No mechanical action of brushhead
Taylor 1995	Less than 28 days
Tenenbaum 1984	Less than 28 days
Terezhalmy 1994	Not RCT
Thienpont 2001	Cross-over study, contacted authors for more information, no reply after 3 months
Timmerman 1995	Less than 28 days
Toto 1961	Not RCT
Toto 1967	Outcomes not under consideration
Trimpeneers 1996	Duplicate abstract of included study
Trimpeneers 1997	Cross-over study, contacted authors for more information, no reply after 3 months
Trombelli 1995	Less than 28 days
Twetman 1997	Not powered versus manual toothbrushing
Vervliet 1989	Split mouth

Characteristics of excluded studies

Walsh 1984	Less than 28 days
Warren 2000	Not powered versus manual toothbrushing
White 1996	Not RCT
Whitmyer 1998	Potential high for compromised self toothbrushing efficacy
Wiedemann 2001	Split mouth
Wilcoxon 1991	Cross-over study, contacted authors for more information, no reply after 3 months
Willershausen 2001	Not RCT
Wilson 1991	Contacted authors for more information, no reply after 3 months
Womack 1968	Not RCT
Ximenez-Fyvie 2000	Supervised or professional cleaning
Yankell 1985	Not RCT
Yankell 1994	Less than 28 days
Youngblood 1985	Laboratory study
Yukna 1993a	Combined intervention
Zimmer 1999	Less than 28 days
van Venrooy 1985	Less than 28 days
van der Weij 1993b	Not powered versus manual toothbrushing
van der Weijden 1993	Supervised brushing
van der Weijden 1995	Not powered versus manual toothbrushing
van der Weijden 1996	Less than 28 days
van der Weijden 1998	Split mouth study
van der Weijden 2001	Not powered versus manual toothbrushing

ADDITIONAL TABLES

Table 01 Summary of characteristics of excluded studies

Reason for exclusion	Number (n=159)
Less than 28 days	60
Not powered versus manual	18
Not RCT	17
Author contacted for more information, no reply after 3 months	12
Split mouth	9
Duplicate abstract or study	8
Potential high for compromised tooth brushing efficacy	6

Table 01 Summary of characteristics of excluded studies

Cross-over trial, authors contacted for more information, no reply after 3 months	5
Outcomes not under consideration	5
Combined intervention	4
No movement of brush head	4
Laboratory study	4
Supervised brushing	4
Not teeth	1
Not human	1
Abstract only	1

Table 02 Summary of inclusion criteria categories within included studies

Inclusion criteria	**Number (n=29)**
No relevant medical history	21
Adults	19
Minimum number of teeth	17
Minimum periodontal baseline measures	16
Participants recruited from dental clinics	5
Concurrent fixed orthodontic treatment	2
Aged less than 16 years	2
Volunteer university students	2
Dental students	1

Table 03 Summary of exclusion criteria categories within included studies

Exclusion criteria	**Number (n=29)**
Pregnancy or lactation	3
Previous use of powered toothbrushes	4
Patients undergoing orthodontic treatment	4
Previous periodontal treatment	2
Dental students	2
Cervical restorations	1
Smoking	0
Maximum periodontal measure	1

Table 04 Summary of toothbrush modes of action, number of trials and participants

Mode of action	Trial ID	Number of trials	n - attrition
Side to side	Glass 1965, Ho 1997, Johnson 1994, Lobene 1964, O'Beirne 1996, Tritten 1996, Walsh 1989, Yankell 1997	8	627
Counter oscillation	Baab 1989, Khocht 1992, Stabholz 1996, Wilson 1993, Yukna 1993	5	228
Rotation oscillation	Ainamo 1997, Barnes 1993, Clerehugh 1998, Cronin 1998, Dentino unpublished, Heasman 1999, Lazarescu unpublished, Stoltze 1994, Warren 2001, Yankell 1997, van der Weijden 1994	11	954
Circular	Khocht 1992, McAllan 1976, Yankell 1996	3	168
Ultrasonic	Forgas Brockman 1998, Terezhalmy 1995	2	108
Unknown	Emling 1991, Soparkar 1964	2	296

Table 05 Sensitivity analyses of trials of rotation oscillation versus manual (1-3mths)

group selected	Index	number of studies	SMD(95%CI)	effect p-value	Het. chi-square	Het. p-value
all studies	plaque	10	-0.44 (-0.66 to -0.21)	<0.001	22.9	0.007
full mouth recording	plaque	8	-0.53 (-0.76 to -0.30)	<0.001	15.8	0.03
adequate concealed allocation	plaque	3	-0.33 (-0.63 to -0.028)	0.032	3.8	0.15
adequate random number generation	plaque	2	-0.24 (-0.68 to 0.20)	0.29	2.4	0.12
outcome assessor blinded	plaque	9	-0.37 (-0.51 to -0.23)	<0.001	6.5	0.60
adequate reporting of attrition	plaque	7	-0.44 (-0.77 to -0.11)	0.009	21.0	0.002

Table 05 Sensitivity analyses of trials of rotation oscillation versus manual (1-3mths)

comparable toothbrush instruction	plaque	6	-0.53 (-0.89 to -0.16)	0.005	20.1	0.001
trials not limited to patients wearing fixed orthodontic appliances	plaque	9	-0.48 (-0.71 to -0.25)	<0.001	19.2	0.01
all studies	gingivitis	10	-0.44 (-0.72 to -0.15)	0.003	38.0	<0.001
full mouth recording	gingivitis	9	-0.47 (-0.79 to -0.15)	0.004	37.1	<0.001
adequate concealed allocation	gingivitis	3	-0.34 (-0.55 to -0.13)	0.002	0.79	0.68
adequate random number generation	gingivitis	2	-0.37 (-0.73 to -0.004)	0.047	1.5	0.21
outcome assessor blinded	gingivitis	9	-0.30 (-0.46 to -0.140)	<0.001	10.5	0.23
adequate reporting of attrition	gingivitis	7	-0.51 (-0.92 to 0.11)	0.012	32.0	<0.001
comparable toothbrush instruction	gingivitis	6	-0.56 (-1.04 to -0.08)	0.02	34.4	<0.001
trials not limited to patients wearing fixed orthodontic appliances	gingivitis	9	-0.47 (-0.79 to -0.15)	0.004	37.4	<0.001

COVER SHEET

Title	**Manual versus powered toothbrushing for oral health**
Reviewer(s)	**Heanue M, Deacon SA, Deery C, Robinson PG, Walmsley AD, Worthington HV, Shaw WC**
Contribution of reviewer(s)	Bill Shaw and Helen Worthington wrote the protocol. Bill Shaw, Mike Heanue, Peter Robinson and Damien Walmsley co-ordinated the review. Bill Shaw wrote the letters to the authors. Bill Shaw, Scott Deacon, Chris Deery, Mike Heanue,

	Peter Robinson and Damien Walmsley independently and in duplicate assessed the eligibility of trials, extracted data and assessed the quality of the trials. Damien Walmsley and Peter Robinson provided the background and sourced information on brush action and plaque and gingival indices. Helen Worthington conducted the statistical analysis. Scott Deacon and Mike Heanue checked and entered data. Peter Robinson and Mike Heanue wrote the review. Proof reading and numerical consistency checked by Chris Deery.
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Date new studies sought but none found	Information not supplied by reviewer
Date new studies found but not yet included/excluded	Information not supplied by reviewer
Date new studies found and included/excluded	Information not supplied by reviewer
Date reviewers' conclusions section amended	Information not supplied by reviewer
Contact address	Professor Bill Shaw Co-ordinating Editor Cochrane Oral Health Group MANDEC, University Dental Hospital of Manchester Higher Cambridge Street Manchester M15 6FH UK Telephone: +44 161 275 6620 E-mail: Bill.Shaw@man.ac.uk Facsimile: +44 161 275 7815
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Editorial group	Cochrane Oral Health Group
Editorial group code	HM-ORAL

SUMMARY TABLES

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Plaque scores at 1 to 3 month at all sites	6	402	Standardised Mean Difference (Random) 95% CI	-0.42 [-0.91, 0.07]
02 Gingival scores at 1 to 3 months at all sites	8	627	Standardised Mean Difference (Random) 95% CI	-0.44 [-0.91, 0.02]
03 Plaque scores at > 3 months	2	220	Standardised Mean Difference (Random) 95% CI	0.03 [-0.23, 0.29]
04 Gingival Scores at > 3 months	2	220	Standardised Mean Difference (Random) 95% CI	0.12 [-0.14, 0.39]

6 + 2 = 8

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Plaque scores at 1 to 3 month at all sites	4	184	Standardised Mean Difference (Random) 95% CI	-0.07 [-0.36, 0.22]
02 Gingivitis scores at 1 to 3 months at all sites	4	172	Standardised Mean Difference (Random) 95% CI	-0.04 [-0.52, 0.45]
03 Plaque scores at > 3 months	2	69	Standardised Mean Difference (Random) 95% CI	-0.63 [-1.11, -0.14]
04 Gingival scores at > 3 months	2	69	Standardised Mean Difference (Random) 95% CI	-0.19 [-0.66, 0.29]

4 + 2 = 6

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Plaque scores at 1 to 3 month at all sites	10	867	Standardised Mean Difference (Random) 95% CI	-0.44 [-0.66, -0.21]
02 Ginigival scores at 1 to 3 months at all sites	10	866	Standardised Mean Difference (Random) 95% CI	-0.45 [-0.76, -0.15]
03 Plaque scores at > 3 months	4	423	Standardised Mean Difference (Random) 95% CI	-1.15 [-2.02, -0.29]

10 + 4 = 14

04 Gingival scores at > 3 months	4	423	Standardised Mean Difference (Random) 95% CI	-0.51 [-0.76, -0.25]

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Plaque scores at 1 to 3 month at all sites	3	168	Standardised Mean Difference (Random) 95% CI	-0.06 [-0.36, 0.25]
02 Gingival scores at 1-3 months at all sites	3	168	Standardised Mean Difference (Random) 95% CI	-0.39 [-0.95, 0.18]
03 Plaque scores at > 3 months	1	40	Standardised Mean Difference (Random) 95% CI	0.04 [-0.58, 0.66]
04 Gingival scores at > 3 months	1	40	Standardised Mean Difference (Random) 95% CI	-0.30 [-0.92, 0.33]

3 + 1 = 4

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Plaque scores at 1 to 3 month at all sites	2	108	Standardised Mean Difference (Random) 95% CI	-0.45 [-0.90, 0.00]
02 Gingival scores at 1 to 3 months at all sites	2	108	Standardised Mean Difference (Random) 95% CI	-0.55 [-1.17, 0.07]
03 Plaque scores at > 3 months at all sites	1	46	Standardised Mean Difference (Random) 95% CI	0.20 [-0.38, 0.78]
04 Gingival scores at > 3 months	1	46	Standardised Mean Difference (Random) 95% CI	0.00 [-0.58, 0.58]

2 + 1 = 3

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Plaque scores at 1 to 3 months at all sites	1	57	Standardised Mean Difference (Random) 95% CI	-0.32 [-0.84, 0.20]
02 Gingival scores at 1 to 3 months at all sites	2	295	Standardised Mean Difference (Random) 95% CI	-0.32 [-0.69, 0.05]

GRAPHS AND OTHER TABLES

Fig. 01 Side to side powered toothbrushes versus manual toothbrushes

01.01 Plaque scores at 1 to 3 month at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 01 Side to side powered toothbrushes versus manual toothbrushes
Outcome: 01 Plaque scores at 1 to 3 month at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
02 Quigley Hein (Turesky)							
Glass 1966	83	0.17 (0.20)	83	0.21 (0.29)		20.8	-0.16 [-0.46, 0.14]
Johnson 1994	24	1.38 (0.60)	19	1.56 (0.37)		16.8	-0.35 [-0.95, 0.26]
Tritten 1996	29	2.14 (0.39)	27	2.21 (0.29)		17.9	-0.20 [-0.73, 0.33]
Yankell 1997	31	2.72 (0.44)	28	2.66 (0.44)		18.1	0.13 [-0.38, 0.65]
Subtotal (95% CI)	187		167			83.7	-0.14 [-0.36, 0.09]
Test for heterogeneity chi-square=1.61 df=3 p=0.6569							
Test for overall effect=-1.23 p=0.2							
03 Silness and Löe							
Ho 1997	12	1.15 (0.17)	12	2.33 (0.44)		8.5	-3.42 [-4.74, -2.09]
Walsh 1999	27	0.90 (0.70)	27	1.00 (0.70)		17.8	-0.14 [-0.67, 0.39]
Subtotal (95% CI)	39		39			16.3	-1.72 [-4.93, 1.49]
Test for heterogeneity chi-square=20.17 df=1 p<0.00001							
Test for overall effect=-1.05 p=0.3							
Total (95% CI)	226		196			100.0	-0.42 [-0.91, 0.07]
Test for heterogeneity chi-square=24.67 df=5 p=0.0002							
Test for overall effect=-1.67 p=0.09							

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01.02 Gingival scores at 1 to 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 01 Side to side powered toothbrushes versus manual toothbrushes
Outcome: 02 Gingival scores at 1 to 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness							
Ho 1997	12	1.42 (0.27)	12	1.96 (0.14)		8.3	-2.42 [-3.52, -1.33]
O'Beirne 1998	20	0.43 (0.36)	20	0.53 (0.49)		12.1	-0.23 [-0.85, 0.39]
Tritten 1996	29	1.12 (0.24)	27	1.19 (0.21)		12.8	-0.31 [-0.83, 0.22]
Walsh 1999	27	1.20 (0.50)	27	1.20 (0.40)		12.8	0.00 [-0.53, 0.53]
Subtotal (95% CI)	88		86			27.6	-0.80 [-1.34, 0.14]
Test for heterogeneity chi-square=15.57 df=3 p=0.0014							
Test for overall effect=-1.59 p=0.11							
02 BOP							
Johnson 1994	24	1.26 (0.18)	19	1.26 (0.21)		12.2	-0.10 [-0.70, 0.50]
Subtotal (95% CI)	24		19			7.2	-0.10 [-0.70, 0.50]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.33 p=0.7							
04 Lobene gingival index							
Glass 1966	83	1.40 (0.63)	83	1.37 (0.66)		14.4	0.06 [-0.26, 0.38]
Lobene 1984a	92	0.39 (0.24)	93	0.72 (0.32)		14.4	-1.18 [-1.47, -0.88]
Yankell 1997	31	2.13 (0.20)	28	2.14 (0.32)		13.0	-0.04 [-0.55, 0.47]
Subtotal (95% CI)	206		204			65.2	-0.39 [-1.24, 0.46]
Test for heterogeneity chi-square=33.03 df=2 p<0.00001							
Test for overall effect=-0.90 p=0.4							
Total (95% CI)	318		309			100.0	-0.44 [-0.91, 0.02]
Test for heterogeneity chi-square=49.99 df=7 p<0.00001							
Test for overall effect=-1.88 p=0.06							

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01.03 Plaque scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 01 Side to side powered toothbrushes versus manual toothbrushes
Outcome: 03 Plaque scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Silness and Löe							
Walsh 1989	27	0.70 (0.70)	27	0.70 (0.70)		24.6	0.00 [-0.53, 0.53]
Subtotal (95% CI)	27		27			24.6	0.00 [-0.53, 0.53]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.00 p=1.0							
02 Quigley Hein (Turesky)							
Glass 1995	83	0.18 (0.22)	83	0.17 (0.28)		75.5	0.04 [-0.26, 0.34]
Subtotal (95% CI)	83		83			75.5	0.04 [-0.26, 0.34]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.26 p=0.8							
Total (95% CI)	110		110			100.0	0.03 [-0.23, 0.29]
Test for heterogeneity chi-square=0.02 df=1 p=0.8996							
Test for overall effect=0.22 p=0.8							

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01.04 Gingival Scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 01 Side to side powered toothbrushes versus manual toothbrushes
Outcome: 04 Gingival Scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness							
Walsh 1989	27	1.10 (0.40)	27	1.10 (0.40)		24.6	0.00 [-0.53, 0.53]
Subtotal (95% CI)	27		27			24.6	0.00 [-0.53, 0.53]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.00 p=1.0							
02 Lobene Gingival Index							
Glass 1995	83	1.36 (0.57)	83	1.26 (0.54)		75.4	0.18 [-0.14, 0.47]
Subtotal (95% CI)	83		83			75.4	0.18 [-0.14, 0.47]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=1.04 p=0.3							
Total (95% CI)	110		110			100.0	0.12 [-0.14, 0.39]
Test for heterogeneity chi-square=0.27 df=1 p=0.6057							
Test for overall effect=0.90 p=0.4							

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Fig. 02 Counter oscillation

02.01 Plaque scores at 1 to 3 month at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 02 Counter oscillation
Outcome: 01 Plaque scores at 1 to 3 month at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
02 Quigley Hein (Turesky)							
Khocht 1992	32	1.84 (0.32)	31	1.86 (0.46)		34.4	-0.05 [-0.54, 0.44]
Stabholz 1998	26	2.03 (0.56)	26	2.00 (0.45)		28.4	0.06 [-0.49, 0.60]
Wilson 1993	16	2.01 (0.69)	13	2.27 (0.60)		16.3	-0.39 [-1.13, 0.35]
Yukna 1993b	20	0.58 (0.41)	20	0.60 (0.33)		21.8	-0.06 [-0.67, 0.57]
Subtotal (95% CI)	94		90			100.0	-0.07 [-0.36, 0.22]
Test for heterogeneity chi-square=0.93 df=3 p=0.8177							
Test for overall effect=-0.49 p=0.6							
Total (95% CI)	94		90			100.0	-0.07 [-0.36, 0.22]
Test for heterogeneity chi-square=0.93 df=3 p=0.8177							
Test for overall effect=-0.49 p=0.6							

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02.02 Gingivitis scores at 1 to 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 02 Counter oscillation
Outcome: 02 Gingivitis scores at 1 to 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
02 Gingival Index Löe							
Baab 1989	20	1.28 (0.27)	20	1.43 (0.13)		24.3	-0.69 [-1.33, -0.05]
Khoht 1992	32	1.06 (0.16)	31	0.99 (0.16)		29.2	0.43 [-0.07, 0.93]
Subtotal (95% CI)	52		51			59.0	-0.11 [-1.22, 0.99]
Test for heterogeneity chi-square=7.36 df=1 p=0.0066							
Test for overall effect=-0.20 p=0.8							
03 Lobene gingival index							
Yukna 1993b	20	0.32 (0.33)	20	0.33 (0.31)		26.0	-0.03 [-0.66, 0.59]
Subtotal (95% CI)	20		20			23.9	-0.03 [-0.66, 0.59]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.10 p=0.9							
04 BOP							
Wilson 1993	16	0.93 (0.36)	13	0.91 (0.33)		21.5	0.06 [-0.69, 0.79]
Subtotal (95% CI)	16		13			17.1	0.06 [-0.69, 0.79]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.16 p=0.9							
Total (95% CI)	88		84			100.0	-0.04 [-0.52, 0.45]
Test for heterogeneity chi-square=7.41 df=3 p=0.0599							
Test for overall effect=-0.16 p=0.9							

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02.03 Plaque scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 02 Counter oscillation
Outcome: 03 Plaque scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Quigley Hein (Turesky)							
Wilson 1993	16	2.24 (0.68)	13	2.62 (0.48)		41.3	-0.69 [-1.44, 0.07]
Yukna 1993b	20	0.44 (0.35)	20	0.67 (0.42)		58.7	-0.58 [-1.22, 0.06]
Subtotal (95% CI)	36		33			100.0	-0.63 [-1.11, -0.14]
Test for heterogeneity chi-square=0.04 df=1 p=0.837							
Test for overall effect=-2.62 p=0.01							
Total (95% CI)	36		33			100.0	-0.63 [-1.11, -0.14]
Test for heterogeneity chi-square=0.04 df=1 p=0.837							
Test for overall effect=-2.62 p=0.01							

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02.04 Gingival scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 02 Counter oscillation
Outcome: 04 Gingival scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Lobene gingival index							
Yukna 1993b	20	0.30 (0.24)	20	0.36 (0.30)		58.3	-0.18 [-0.80, 0.44]
Subtotal (95% CI)	20		20			58.3	-0.18 [-0.80, 0.44]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.57 p=0.6							
02 BOP							
Wilson 1993	16	0.86 (0.34)	13	0.93 (0.37)		41.7	-0.19 [-0.93, 0.54]
Subtotal (95% CI)	16		13			41.7	-0.19 [-0.93, 0.54]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.51 p=0.6							
Total (95% CI)	36		33			100.0	-0.19 [-0.66, 0.29]
Test for heterogeneity chi-square=0.00 df=1 p=0.9805							
Test for overall effect=-0.77 p=0.4							

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Fig. 03 Rotation oscillation

03.01 Plaque scores at 1 to 3 month at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 03 Rotation oscillation
Outcome: 01 Plaque scores at 1 to 3 month at all sites

Study	Powered N	Powered Mean (SD)	Manual N	Manual Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
02 Quigley Hein (Turesky)							
Barnes 1993	34	2.45 (0.38)	35	2.70 (0.55)		9.5	-0.52 [-1.00, -0.04]
Cronin 1998	55	2.28 (0.65)	50	2.55 (0.54)		11.3	-0.46 [-0.83, -0.08]
Dentino unpublished	76	1.67 (0.46)	81	1.80 (0.40)		12.7	-0.53 [-0.85, -0.21]
Heasman 1999	50	1.26 (0.62)	24	1.53 (0.50)		9.3	-0.52 [-1.01, -0.03]
Warren 2001	52	2.29 (0.46)	49	2.47 (0.50)		11.2	-0.37 [-0.77, 0.02]
Yankell 1997	28	2.66 (0.39)	28	2.66 (0.44)		8.8	0.00 [-0.52, 0.52]
Subtotal (95% CI)	295		267			65.2	-0.43 [-0.60, -0.26]
Test for heterogeneity chi-square=3.34 df=5 p=0.6477							
Test for overall effect=-4.97 p<0.00001							
03 Silness and Löe							
Stoltze 1994	20	0.60 (0.27)	18	1.10 (0.21)		5.4	-2.01 [-2.81, -1.21]
van der Weijden 1994	42	0.87 (0.36)	35	1.01 (0.33)		10.0	-0.41 [-0.86, 0.05]
Subtotal (95% CI)	62		53			12.0	-1.17 [-2.74, 0.40]
Test for heterogeneity chi-square=11.78 df=1 p=0.0006							
Test for overall effect=-1.46 p=0.14							
09 Ortho modification of Silness and Löe							
Clerehugh 1998	37	1.00 (0.30)	42	1.00 (0.34)		10.2	0.00 [-0.44, 0.44]
Subtotal (95% CI)	37		42			9.5	0.00 [-0.44, 0.44]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.00 p=1.0							
10 Visible plaque index Ainamo Bay							
Ainamo 1997	55	0.39 (0.16)	56	0.43 (0.16)		11.8	-0.26 [-0.63, 0.12]
Subtotal (95% CI)	55		56			13.3	-0.26 [-0.63, 0.12]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-1.34 p=0.18							
Total (95% CI)	449		418			100.0	-0.44 [-0.66, -0.21]
Test for heterogeneity chi-square=22.87 df=9 p=0.0065							
Test for overall effect=-3.83 p=0.0001							

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03.02 Ginigival scores at 1 to 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 03 Rotation osciliation
Outcome: 02 Ginigival scores at 1 to 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness mod Lobene							
Barnes 1993	34	2.24 (0.42)	35	2.58 (0.57)		9.9	-0.67 [-1.16, -0.18]
Subtotal (95% CI)	34		35			9.9	-0.67 [-1.16, -0.18]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-2.70 p=0.007							
02 Löe and Silness							
Clerehugh 1998	37	1.67 (0.18)	42	1.70 (0.17)		10.4	-0.17 [-0.61, 0.27]
Cronin 1998	55	0.94 (0.12)	60	1.00 (0.10)		10.9	-0.54 [-0.93, -0.15]
Heasman 1999	50	1.55 (0.21)	24	1.64 (0.22)		9.9	-0.42 [-0.91, 0.07]
Stoltze 1994	20	0.90 (0.04)	18	1.10 (0.08)		5.6	-3.16 [-4.13, -2.17]
Warren 2001	52	0.89 (0.12)	40	0.94 (0.13)		10.9	-0.40 [-0.79, 0.00]
Subtotal (95% CI)	214		183			43.7	-0.78 [-1.38, -0.19]
Test for heterogeneity chi-square=30.46 df=4 p<0.00001							
Test for overall effect=-2.57 p=0.01							
04 Lobene gingival index							
Dentino unpublished	76	0.49 (0.25)	81	0.59 (0.26)		11.6	-0.39 [-0.71, -0.07]
Yankell 1997	28	2.16 (0.28)	28	2.14 (0.32)		9.5	0.07 [-0.46, 0.59]
van der Weijden 1994	42	1.16 (0.28)	35	1.12 (0.24)		10.3	0.12 [-0.33, 0.57]
Subtotal (95% CI)	146		144			35.0	-0.11 [-0.46, 0.24]
Test for heterogeneity chi-square=4.22 df=2 p=0.1213							
Test for overall effect=-0.61 p=0.5							
07 BOP Ainamo Bay							
Ainamo 1997	55	0.24 (0.10)	55	0.26 (0.09)		11.1	-0.21 [-0.58, 0.17]
Subtotal (95% CI)	55		55			13.4	-0.21 [-0.58, 0.17]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-1.09 p=0.3							
Total (95% CI)	449		417			100.0	-0.46 [-0.76, -0.15]
Test for heterogeneity chi-square=41.67 df=9 p<0.00001							
Test for overall effect=-2.92 p=0.004							

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03.03 Plaque scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 03 Rotation osciliation
Outcome: 03 Plaque scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Quigley Hein (Turesky)							
Dentino unpublished	76	1.10 (0.35)	81	1.39 (0.38)		25.9	-0.81 [-1.14, -0.49]
Lazarescu unpublish	40	1.60 (0.24)	38	2.20 (0.23)		23.4	-2.65 [-3.60, -2.30]
Subtotal (95% CI)	116		119			50.0	-1.86 [-3.95, 0.23]
Test for heterogeneity chi-square=33.11 df=1 p<0.00001							
Test for overall effect=-1.74 p=0.08							
02 Visible plaque index Ainamo Bay							
Ainamo 1997	55	0.34 (0.16)	58	0.39 (0.19)		25.6	-0.28 [-0.66, 0.09]
Subtotal (95% CI)	55		58			30.3	-0.28 [-0.66, 0.09]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-1.48 p=0.14							
03 Silness and Löe							
van der Weijden 1994	42	0.55 (0.25)	35	0.73 (0.24)		25.0	-0.73 [-1.19, -0.26]
Subtotal (95% CI)	42		35			19.7	-0.73 [-1.19, -0.26]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-3.07 p=0.002							
Total (95% CI)	213		210			100.0	-1.15 [-2.02, -0.29]
Test for heterogeneity chi-square=40.18 df=3 p<0.00001							
Test for overall effect=-2.61 p=0.009							

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03.04 Gingival scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 03 Rotation oscillation
Outcome: 04 Gingival scores at > 3 months

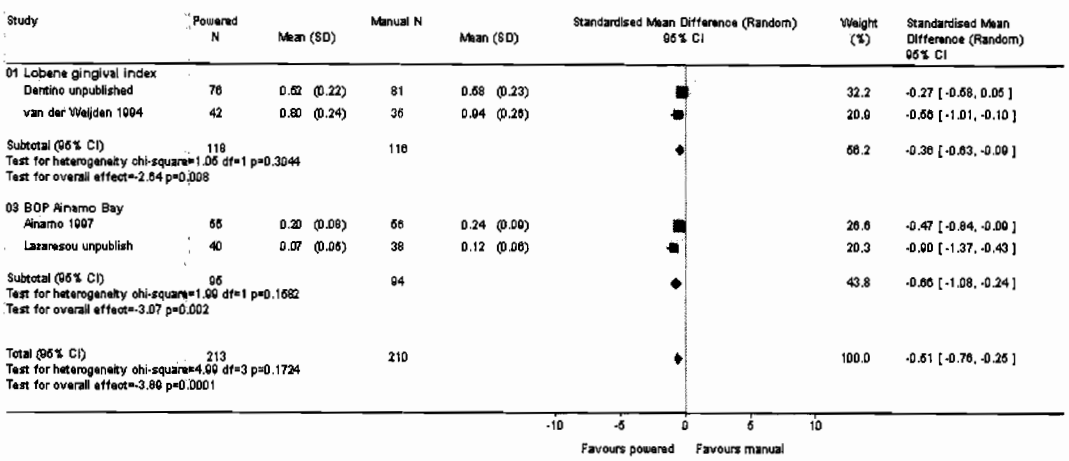
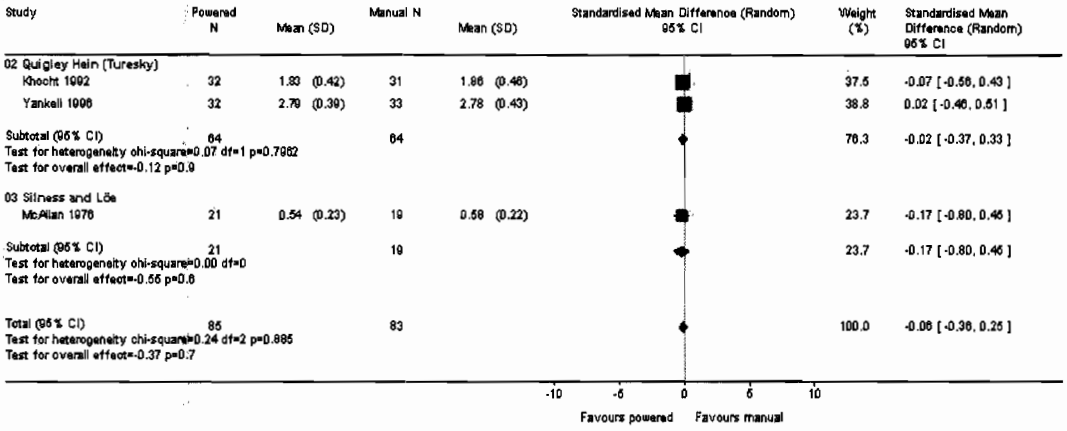


Fig. 04 Circular

04.01 Plaque scores at 1 to 3 month at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 04 Circular
Outcome: 01 Plaque scores at 1 to 3 month at all sites



04.02 Gingival scores at 1-3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 04 Circular
Outcome: 02 Gingival scores at 1-3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Lobene							
Yankell 1996	32	2.00 (0.54)	33	2.21 (0.25)		36.3	-0.50 [-0.99, 0.00]
Subtotal (95% CI)	32		33			36.3	-0.50 [-0.99, 0.00]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-1.97 p=0.05							
02 01 Löe Silness							
Khocht 1992	32	1.01 (0.14)	31	0.99 (0.16)		36.3	0.13 [-0.36, 0.63]
McAllan 1976	21	0.28 (0.09)	19	0.40 (0.17)		29.4	-0.88 [-1.53, -0.22]
Subtotal (95% CI)	53		50			61.1	-0.36 [-1.34, 0.64]
Test for heterogeneity chi-square=5.84 df=1 p=0.0157							
Test for overall effect=-0.69 p=0.5							
Total (95% CI)	85		83			100.0	-0.39 [-0.95, 0.18]
Test for heterogeneity chi-square=6.48 df=2 p=0.0391							
Test for overall effect=-1.34 p=0.18							

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04.03 Plaque scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 04 Circular
Outcome: 03 Plaque scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Silness and Löe							
McAllan 1976	21	0.51 (0.23)	19	0.50 (0.22)		100.0	0.04 [-0.58, 0.66]
Subtotal (95% CI)	21		19			100.0	0.04 [-0.58, 0.66]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.14 p=0.9							
Total (95% CI)	21		19			100.0	0.04 [-0.58, 0.66]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.14 p=0.9							

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04.04 Gingival scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 04 Circular
Outcome: 04 Gingival scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness							
McAllan 1976	21	0.42 (0.09)	19	0.47 (0.22)		100.0	-0.30 [-0.92, 0.33]
Subtotal (95% CI)	21		19			100.0	-0.30 [-0.92, 0.33]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.93 p=0.4							
Total (95% CI)	21		19			100.0	-0.30 [-0.92, 0.33]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.93 p=0.4							

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Fig. 05 Ultrasonic

05.01 Plaque scores at 1 to 3 month at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 05 Ultrasonic
Outcome: 01 Plaque scores at 1 to 3 month at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
02 Quigley Hein (Turesky)							
Forgas-B 1998	30	2.86 (0.42)	26	3.00 (0.59)		50.3	-0.88 [-1.22, -0.14]
Terezhalmy 1995a	26	3.07 (0.49)	26	3.15 (0.12)		49.7	-0.22 [-0.77, 0.32]
Subtotal (95% CI)	56		52			100.0	-0.45 [-0.90, 0.00]
Test for heterogeneity chi-square=1.38 df=1 p=0.2393							
Test for overall effect=-1.96 p=0.05							
Total (95% CI)	56		52			100.0	-0.45 [-0.90, 0.00]
Test for heterogeneity chi-square=1.38 df=1 p=0.2393							
Test for overall effect=-1.96 p=0.05							

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05.02 Gingival scores at 1 to 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 05 Ultrasonic
Outcome: 02 Gingival scores at 1 to 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness							
Forgas-B 1998	30	1.47 (0.31)	26	1.55 (0.34)		51.6	-0.24 [-0.77, 0.28]
Terezhalmy 1995a	26	0.71 (0.26)	26	0.89 (0.12)		48.4	-0.88 [-1.45, -0.30]
Subtotal (95% CI)	56		52			100.0	-0.55 [-1.17, 0.07]
Test for heterogeneity chi-square=2.64 df=1 p=0.1109							
Test for overall effect=-1.74 p=0.08							
Total (95% CI)	56		52			100.0	-0.55 [-1.17, 0.07]
Test for heterogeneity chi-square=2.64 df=1 p=0.1109							
Test for overall effect=-1.74 p=0.08							

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05.03 Plaque scores at > 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 05 Ultrasonic
Outcome: 03 Plaque scores at > 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Quigley Hein							
Terezhalmy 1995a	23	0.82 (0.32)	23	0.75 (0.27)		100.0	0.20 [-0.38, 0.78]
Subtotal (95% CI)	23		23			100.0	0.20 [-0.38, 0.78]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.67 p=0.5							
Total (95% CI)	23		23			100.0	0.20 [-0.38, 0.78]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.67 p=0.5							

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05.04 Gingival scores at > 3 months

Review: Manual versus powered toothbrushing for oral health
Comparison: 05 Ultrasonic
Outcome: 04 Gingival scores at > 3 months

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness							
Terezhalmy 1995a	23	0.33 (0.23)	23	0.33 (0.26)		100.0	0.00 [-0.58, 0.58]
Subtotal (95% CI)	23		23			100.0	0.00 [-0.58, 0.58]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.00 p=1.0							
Total (95% CI)	23		23			100.0	0.00 [-0.58, 0.58]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=0.00 p=1.0							

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Fig. 06 Unknown or other action

06.01 Plaque scores at 1 to 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 06 Unknown or other action
Outcome: 01 Plaque scores at 1 to 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Quigley Hein (Turesky)							
Emling 1991	28	2.01 (0.50)	29	2.18 (0.54)		100.0	-0.32 [-0.84, 0.20]
Subtotal (95% CI)	28		29			100.0	-0.32 [-0.84, 0.20]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-1.21 p=0.2							
Total (95% CI)	28		29			100.0	-0.32 [-0.84, 0.20]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-1.21 p=0.2							

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06.02 Gingival scores at 1 to 3 months at all sites

Review: Manual versus powered toothbrushing for oral health
Comparison: 06 Unknown or other action
Outcome: 02 Gingival scores at 1 to 3 months at all sites

Study	Powered N	Mean (SD)	Manual N	Mean (SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Löe and Silness							
Emling 1991	28	1.21 (0.47)	29	1.24 (0.54)		33.8	-0.06 [-0.58, 0.46]
Subtotal (95% CI)	28		29			21.1	-0.06 [-0.58, 0.46]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-0.22 p=0.8							
02 Quigley and Hein							
Soparkar 1994	85	0.37 (0.34)	153	0.56 (0.45)		66.2	-0.46 [-0.73, -0.19]
Subtotal (95% CI)	85		153			78.9	-0.46 [-0.73, -0.19]
Test for heterogeneity chi-square=0.00 df=0							
Test for overall effect=-3.34 p=0.0008							
Total (95% CI)	113		182			100.0	-0.32 [-0.69, 0.05]
Test for heterogeneity chi-square=1.79 df=1 p=0.1812							
Test for overall effect=-1.71 p=0.09							

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